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ON THE SYSTEMATIC VALUE OF RANA CHINENSIS OSBECK.

BY DR. STEFAN BOLKAY.

In an article which I published in "Állattani Kozlemények (3)", I separated as a distinct species *Rana ridibunda* from *Rana esculenta*. After the publication of that paper Professor Dr. Méhely directed my attention to a frog found in China and Japan which is mentioned in literature, according to Boulenger, as a variety of *R. esculenta* (*Rana esculenta chinensis* Osb.), but which, however, as Professor Méhely observed, can be separated with more right from *R. esculenta* than is *R. ridibunda*.

A short time afterward my article appeared in German also (4), and was commended by Wolterstorff who wrote as follows on that subject: "As soon as we acknowledge the right of a species for *Rana ridibunda* we must do the same with more reason still for *Rana chinensis*, a fact also recognized not long ago by Stejneger."

Wolterstorff considers this same question in one of his articles, published in 1906, and there expresses his conviction that *Rana chinensis* is a well-defined subspecies.

Quite recently Leonhard Stejneger, the American herpetologist, described *Rana chinensis* as a distinct species under the name *Rana nigromaculata* Hallowell.

The first author who describes *Rana chinensis* is Osbeck. He mentions as the sole peculiarity distinguishing it from *R. esculenta* the fact of its having six toes of which the sixth is the shortest.

Schlegel finds it quite similar to *R. esculenta*. Maack alludes to it as *R. esculenta var. japonica* Hallowell and describes it under the two names *R. marmorata* and *R. nigromaculata*. Peters and Cope go furthest, placing it in an other genus, the former mentioning

it as *Hoplobatrachus reinhardti*, the latter under the name *Tomopterus porosa*. Lataste calls it *R. esculenta marmorata*. Boulenger refers to it at first as *R. esculenta var. japonica*, then as *var. nigromaculata*, and quite lately as *var. chinensis* Osbeck.

R. chinensis has been mentioned only once in Hungarian literature, Professor von Méhely describing as *R. esculenta var. chinensis* the three specimens collected at Peking by the Zichy expedition.

The great confusion existing in literature upon that question, as well as the statements by Professor von Méhely and Professor Wolterstorff, induced me to study the Chinese frog. My aim is to point out, with especial regard to the osteological marks, the systematic position of *R. chinensis*, and to prove at last that the Chinese frog has nothing to do with *R. esculenta*, and that taking all of its characteristic features into consideration, it can be placed near to *R. ridibunda* Pallas.

I find it necessary to give a detailed description of the species, improved and completed by the result of recent observations made upon specimens from the Hungarian National Museum as well as upon others from China bought at Magdeburg from Wolterstorff. Having pursued my investigations in the Hungarian National Museum, I wish here to express particular thanks to Professor von Méhely for the kind assistance he lent me in my work, allowing me the benefit of the Museum's material as well as giving me most valuable information.

RANA CHINENSIS Osbeck.

Synonymy.[1]

1765. *Rana chinensis* Osbeck, Reise Ostind. China, I, (p. 244); Voy. China (Engl. ed.), I, 1771, p. 299 (Canton, China).

1906. *Rana esculenta* subsp. *chinensis* Wolterstorff, Abhdl. Berichte d. Mus. f. Natur. und Heimatkunde zu Magdeburg, Bd. I, Heft 3, 1906, pp. 135–143.

1907. *Rana nigromaculata*, Stejneger, Herpetology of Japan and adjacent Territory, Bull. U. S. Nat. Mus. No. 58, p. 94, pl. 10, fig. 1.

[1] For complete Synonymy see Stejneger, Herpetology of Japan, cited above.

Description.

Vomerine teeth in two slightly oblique groups between the choanæ very seldom extending to the line joining the posterior border of the choanæ. The male's head is generally narrower, that of the female rather broader than its length. The snout is pointed and projects beyond the mouth; the distance from the anterior corner of the eye is always longer than the eye's horizontal diameter; *canthus rostralis* strongly marked; loreal region slanting, rather sunken; nostrils considerably nearer to the eyes than to the tip of the snout; interorbital space contained about one and a half times in that between the nostrils and about twice in the breadth of the upper eyelid; (these measurements are subject to slight variations.) Tympanum well developed, its horizontal diameter longer than the vertical, equal to two-thirds, at most, to three-quarters of the diameter of the eye.

The fingers of the fore limbs are rather pointed, the first longer than the second; the subarticular tubercles are prominent, and well developed.

The hind limbs being carried forward along side of the body the tibio-tarsal joint reaches the posterior corner of the eye, or at most to between the anterior corner of the eye and the nostril; tibia always much shorter than the fore limb, or the foot measured from the outer meta-tarsal tubercle; when the hind limbs are bent at right angles to axis of body, heels never do meet; toes entirely webbed; the subarticular tubercles small and not very prominent; the inner meta-tarsal tubercle (Plate VI, fig. 1) very large, projecting, compressed, on both sides, hard and sharp, twice as long as high; its length contained 1–1.8 times in length of inner toe and 4.8–7.5 times in that of the tibia; it is most characteristic, that the inner meta-tarsal tubercle is never parallel with the length-axis of the sole but invariably forms a greater or smaller angle with it. It is very characteristic, further, that the inner meta-tarsal tubercle never adheres to the base of the thumb but is attached to it in a mobile way with a web, spreading between it and the thumb. At the root of the fourth (longest) finger there is always a small, roundish outer meta-tarsal tubercle.

The glandular lateral folds are well developed, their width being at least equal to one-third of an upper eyelid, not seldom, however, attaining the entire breadth of it; the distance between the lateral folds,—measured on the scapular region,—is contained $4\frac{1}{4}$–$5\frac{1}{2}$ times in whole length of head and body.

On the back, on both sides of dorsal line, longitudinal dorsal folds, which vary in length but are always sharply projecting; these are generally disposed in six longitudinal rows, on the anterior part of the back, and in eight on the posterior part of it; breadth of one fold amounts to about half of inter-orbital space, greatest length, to twice the length of the upper eyelid, frequently, however, equal to $4\frac{1}{3}$. The back of one of the specimens found at Pingshiang, besides the usual folds, is covered with innumerable small warts, which make it look unusually warty.

Chin, throat and fore part of belly smooth; sides of body and lower hind part of thighs alone somewhat granulated, the hind part of belly crosswise slightly wrinkled.

Color (taken from spirit-specimens): Back brownish olive, sprinkled with black spots; the latter present three main types: either unequally rounded as in our *R. esculenta*, or lengthwise extended (specimens from Japan) or again are they of such a shape as we never meet with in our *R. esculenta* viz. in most of the Chinese specimens the black spots widen horizontally.

The vertebral line is pale blue and varies in breadth; the dorso-lateral folds of same color; on the *canthus-rostralis*, beginning at the end of snout, passing across the eye, above the tympanum and at the back of it, runs the black stripe which reaches down behind the angle of the mouth; along the outer side of the dorso-lateral folds, the black spots most frequently melt into a single black stripe; on sides of body large, irregular black spots are to be seen, which often unite into a large black stripe between the articulation of the two extremities; the upper edge of the stripe is undulating and from the lower one, following close upon each other, several branches extend towards the belly. The dark spots on the edge of the upper lip never unite into a single dark stripe.

Upper surface of limbs, tibias, and feet crossed by dark bars. In Japanese specimens we find the dark crossbars of the upper

limbs and tibias invariably detached into blotches.[2] The hind part of the thighs is whitish-grey with dark marblings; belly uniform white, border of lower jaw, however, together with throat region, breast, both sides of belly and thighs, slightly marbled with a darker tint. The vocal sacs are blackish-grey.

Osteological characters. The skull (Plate VI, fig. 2) presents partly the characteristic marks of *esculenta* and partly those of *R. ridibunda*, general form narrow and longish; becoming (gradually) narrower and pointed in front, always narrower than it is long; the *cranium cerebrale* is comparatively higher than in *R. esculenta*. The *pars facialis* of the maxillary much higher than with the *esculenta*. Nasals narrow and meeting at a sharp angle in the middle line, joining each other in a broad ridge, contrarily to the arrangement in *R. esculenta* in which they are broad, meeting at a blunt angle and generally not in contact on the middle line.

The two borders of the fronto-parietals are—in old examples—quite parallel, in younger ones slightly converging forwards; breadth of their inter-orbital space—measured in the middle—is contained 3–3.5 times in its length; posterior border almost straight; upper surface very slightly sunken, *sutura-sagittalis* always entirely ossified.

With *R. esculenta* the fronto-parietals' two outer borders are never parallel, becoming conspicuously narrower towards the front. Their breadth between the orbits, measured in the middle is but 2.5–3 times contained in their length; their back edge is always undulating; their upper surface is deeply sunken; *sutura-sagittalis* open from *os ethmoideum* until about the middle.

Tectum synoticum always triangular, whilst in *R. esculenta* it is invariably quadrangular.

Prooticum always shorter and broader than in *R. esculenta*. The *tympanicum* presents in its formation such differences as separate most markedly the skull of *R. chinensis* from that of *R. esculenta*. The forepart of the *tympanicum*, the zygomatic process, is straight, narrow and long, just reaching the half of the longitudinal diameter of the orbit, sometimes even extending rather beyond it; never curved inwards, being on the contrary, always expanded in front, its

[2] Stejneger (p. 98) mentions specimens from the collection of Dr. Smith and Owston, from Shikoku Islands and Mount Fuji in which the dark blotches on the hind limbs melt into quite distinct crossbars.

Measurements

MEASUREMENTS IN MM.	PEKING		PINGSHIANG				KIUKIANG		JAPAN	
	♂	♀	♂	♀	♂	♀	♀	♀	♂	♀
From snout to vent	66	66	69	69	59	67	90	92	54	52.5
Length of head	22.5	21.5	24.5	23	20.5	22.5	29.5	29	18.5	18.5
Width of head	21.5	22.5	23.5	22	21	22.5	30.5	29.5	17.5	17.5
Diameter of eye	7.5	7	7.5	7.5	7.5	8.5	10.5	10	6.5	7
Interorbital width	3	3	3	2.5	2.5	2.5	4	3.5	2.5	2
From eye to nostril	4.5	5	5	5	4	5	6	6.5	4.5	4.5
From eye to end of snout	10.5	10.5	11.5	10.5	10	10	14	14.5	9	9.5
Diameter of tympanum	5	4.5	6.5	5	5	5	6.5	6.5	4	4.5
Fore limb	35	33	38.5	35.5	32	36	48	45	29.5	28
Hind limb	101.5	98	106.5	110	91	108.5	138	137	87.5	85
Tibia	29.5	29	30	34	29	32	42	44	25.5	25
Length of foot	36	35	37	36.5	33	38	42	46.5	31	28.5
Inner toe (from tubercle)	6	6	6.5	6.5	7	7	8.5	9	6.5	5.5
Inner metatarsal-tubercle	6	6	5	4.5	4.5	4.5	7	6.5	3.5	3.5

foremost end, consequently, never extending into the orbit. This is also the reason why the posterior corner of the inner branch of *tympanicum* forms a still blunter angle than in *R. esculenta*. The back branch of the *tympanicum* is still shorter than in *R. esculenta*, so that the straight line connecting the articulations of the two jaws invariably crosses the *condylus*. The plate of the inner branch of the *tympanicum* is always shorter than in *R. esculenta*.

The intermaxillary's (fig. 3) inner border never sinks so deep as it does in *R. esculenta*.

The vomerine teeth lie between the *choanæ* in two small, semicircular groups inclining towards each other at a very slight angle; the group of teeth are always separated by a larger space than is the case with *R. esculenta* in which the inner edges of the teeth groups sometimes almost meet—and never attain the straight line connecting the posterior border of the *choanæ*.

The palatines differ from those of *R. esculenta* in as much as they bear on their exterior side a rough, prominent bony crest.

Median branch of *os parabasale* is in general narrower and more rounded than in *R. esculenta*. *Foramen occipitale magnum* in old individuals, oval, in very young ones, round.

If we survey (fig. 4) the skull from the back joining the tympanicum's two posterior corners by a line, it will just about cut across the middle of *foramen magnum*. In *R. esculenta* in 90 per cent of the cases this line touches the upper border of the foramen magnum; with *R. ridibunda* the mentioned line invariably crosses the upper third of the foramen magnum.

The vertebral column (excepting the length of the urostylus) is as long as the skull. Characteristic differences are to be found on the second, third and eighth vertebræ. Whilst, with *R. esculenta* the diapophysis of second vertebra presents a cylindric shape (fig. 5), with only a few unimportant protuberances towards the center of the front border, the diapophysis of second vertebra of *R. chinensis* is flat and presents a well developed bony crest on its anterior border (fig. 6). This bony crest is to be found in *R. ridibunda* also. The outer half of the diapophysis of the third vertebra is carved out, shovel-like (fig. 7). On the median side of its posterior edge a projecting bone ridge extends to the base of the diapophysis. This bone ridge is to be found neither in *R. esculenta* nor in *R. ridibunda*.

The diapophysis of the eighth vertebra (fig. 8) generally curves backwards, median side also expanding wing-like backwards.

It is worth mentioning that the *processi spinosi* of the vertebræ are longer on *R. chinensis* than on either *R. esculenta* or *R. ridibunda*. If we join, by a straight line, the back borders of the *processi obliqui* on the second, third and fourth vertebræ we shall find that the *processi spinosi* invariably extend beyond this line. On *R. esculenta* and *R. ridibunda* the *processi spinosi* generally touch that line, sometimes ending a good deal before it.

The urostylus is as long as the vertebral column.

If we examine the pelvis (fig. 9) so that the symmetric plane passing through the symphysis is parallel with the base we will find the following peculiarities: pelvis 1.2–1.3 times as long as the vertebral column; ilium in its general form straight, the extremities touching the sacral vertebra, being alone slightly curved downwards; upper ridge of the ilium's crest straight and the angle of it which declines towards the acetabulum forms only just a somewhat larger angle than a rectangle. This declining angle is smooth, or presents a hardly visible distended margin; if we draw on the ridge of the ilium crest a line parallel to the base of the *pelvis*, this line will just be reached by the upper corner of the *crista ischio-pubica*.

In *R. esculenta* (fig. 10) the pelvis is 1.06–1.2 times as long as the vertebral column; the ilium is curved, the upper ridge of its crest is rounded and the corner declining towards the acetabulum forms a very blunt angle. This declining corner presents a strongly distended margin and consequently under this margin at the base of the ilium we find a somewhat deep cavity; if we draw on the ridge of the ilium crest, a line parallel to the base of the pelvis, we shall notice that the upper corner of the *crista ischio-pubica* remains far under that line.

The most interesting of the tarsus bones is the so-called præhallux (fig. 11) which is a large, flat spade-like bony plate, growing rather thick towards its base; its outer surface somewhat convex, whilst the inner one is very slightly concave; its greatest breadth equal to two-thirds of its length, the latter to two-thirds to three-fourths of the length of first meta-tarsal bone. In *R. esculenta* the præhallux (fig. 12) is a flat, thin bone plate; greatest breadth half its length, length half that of the first meta-tarsal bone.

In both species we find the præhallux joined to the *tibiale* by an intercalated bone, the *tibiale* being formed by the following principal elements: *tarsale præhallucis*, *centrale* and *tarsale I.*

Under the second and third meta-tarsal bones we find the *tarsale II.* and *III.;* the fourth and fifth meta-tarsal bones are joined to the fibulare by the so-called *ligamentum tarsi suppleus.*

Measurements of skeleton in mm.

MEASUREMENTS IN MM.	KIUKIANG ♀	PINGSHIANG ♂	PINGSHIANG ♀
Length of skull	28	24	21
Breadth of skull	27.5	21	20
Interorbital space	4	3	3
Columna vertebralis	29	23.5	20.5
Urostylus	29.5	22	20
Humerus	23.5	18	16
Radius-ulna	15	11.5	10.5
Manus	18	15.5	14
Pelvis	38	28.5	26
Femur	38.5	29	31
Tibia	39	29	31
Tarsus	18	14	13.5
Pes	41.5	35	35.5

Rana chinensis **Osb.**	*Rana ridibunda* **Pall.**	*Rana esculenta* **Linn.**
1. Head narrow, long and very pointed at the end.	1. Head broad, short and tip of snout bluntly rounded.	1. Head comparately narrow, tip of snout ending in blunt point.
2. Inter-orbital space equal to half the breadth of upper eye-lid.	2. Inter-orbital space equal to one third the breadth of upper eye-lid.	2. Inter-orbital space equal to half or frequently to three quarters the breadth of upper eye-lid.
3. Heels never meet when hind limbs are bent at right angles to axis of body.	3. Heels always overlap when hind limbs are bent at right angles to axis of body.	3. Heels never meet when hind limbs are bent at right angles to axis of body.
4. Bending the hind limbs forward along the side of body the tibio-tarsal joint reaches the posterior corner of eye or can prolong itself beyond to space between the anterior corner and nostrils.	4. Bending the hind limbs forward along side of body, the tibio-tarsal joint reaches with the female, the back corner of eye, with male the end of snout.	4. Bending the hind limbs forward along side of body the tibio-tarsal joint reaches, on the female the space between the tympanum and posterior corner of eye, on the male,—at the utmost—space between the anterior corner and nostrils.

5. The inner meta-tarsal tubercle is very large, projecting, compressed on both sides, hard and sharp; always a good deal longer than the distance between the subarticular tubercle of first toe and inner meta-tarsal tubercle, frequently equal to length of first toe.

6. The subarticular tubercles on toes of hind limbs small and only slightly projecting.

7. The vocal sacs are blackish grey.

8. The spaces between the dusky marbling on the back surface of thighs is filled (according to Boulenger) by a yellow color.

9. The dark spots of back,—on Chinese specimens—expand horizontally.

10. Fold on the back, between the two dorso-lateral folds in 6–8 longitudinal rows, varying in length.

11. Skull invariably narrower than long, very pointed at the end.

12. Vomerine teeth never meet the line joining posterior border of *choanæ*.

13. The nasals form a sharp angle towards each other and meet in a broad ridge on middle line.

14. Side borders of fronto-parietals parallel with upper surface slightly sunken in.

15. *Tectum synoticum* triangular.

5. Inner meta-tarsal tubercle small, of a flattened cylindrical form not very projecting, always shorter than space between the sub-articular tubercle of first toe and inner meta-tarsal tubercle.

6. The subarticular tubercles on toes of hind limbs larger and more projecting.

7. Vocal sacs blackish grey.

8. Spaces between dark marbling on back surface of thighs is never filled with a sulphuric color.

9. It is rare that the dark spots of back expand horizontally and that happens only in a small degree.

10. No glandular dorsal folds on back.

11. Skull invariably broader than it is long, in front gradually narrowing.

12. Vomerine teeth extend slightly behind the level of *choanæ*.

13. The nasals form a rectangle or a somewhat blunt angle and meet in a broad ridge on the middle line.

14. Side borders of fronto-parietals converging forwards, upper surface deeply hollowed.

15. *Tectum synoticum* triangular.

5. Inner meta-tarsal tubercle large, compressed on both sides, projecting; always longer than distance between the subarticular tubercle of first toe and inner meta-tarsal tubercle.

6. The subarticular tubercles on toes of hind limbs are largest and strongly projecting.

7. Vocal sacs milky white.

8. Spaces between dark marbling on back surface of thighs always filled with sulphur colored spots.

9. The dark spots on back never expand horizontally.

10. No glandular dorsal folds on back.

11. Skull generally as broad as long, front part forms a sudden point.

12. Vomerine teeth generally touch the line joining the posterior border of *choanæ*.

13. The nasals form a blunt angle and do not meet on the middle line.

14. Side borders of fronto-parietals converge conspicuously forwards, upper surface deeply hollowed.

15. *Tectum synoticum* quadrangular.

16. Foramen magnum oval.

17. The *processus zygomaticus* of *tympanicum* expand forwards, just reach to half the length of orbit.

18. Back corner of inner branch of *tympanicum* forms very blunt angle.

19. Back branch of *tympanicum* very short so that the *condylus* always extends beyond line joining the articulation of jaws.

20. If we join by a line the posterior corners of inner branch of *tympanicum*, this line invariably crosses *foramen magnum* in the middle.

21. *Diapophysis* of second vertebra flat, outer side of front border presents a prominent long crest.

22. Outer side of *diapophysis* of third vertebra is carved out shovel-like and on median side of back border a strong, projecting bone ridge extends to the base of the *diapophysis*.

23. *Diapophysis* of eighth vertebra generally curved backwards median side expanding wing-like, backwards.

24. *Processi spinosi* of vertebrae longer.

25. If we draw on pelvis on the upper border of ilium crest a line parallel to base of pelvis, this line will just be attained by upper corner of *crista ischio pubica*.

16. Foramen magnum oval.

17. The *processus zygomaticus* of *tympanicum* curved inwards invariably extends beyond half the length of orbit.

18. Back corner of inner branch of *tympanicum* frequently forms a sharp angle, rather projecting backwards.

19. Back branch of *tympanicum* long, so that the line joining the articulation of jaws remains far behind the *condylus*.

20. If we join by a line the posterior corners of inner branch of *tympanicum* this line generally crosses *foramen magnum* in its upper third.

21. *Diapophysis* of second vertebra cylindrical, outer side of front border presents a slight bony crest.

22. Outer side of *diapophysis* of third vertebra shovel-like carved out.

23. *Diapophysis* of eighth vertebra expanding backwards in the form of a wing.

24. *Processi spinosi* of vertebrae shorter.

25. If we draw on pelvis on the upper border of ilium crest, a line parallel to base of pelvis, the upper corner of *crista ischio pubica* will remain much below this line.

16. Foramen magnum of a somewhat circular form.

17. *Processus zygomaticus* of *tympanicum* curved inwards, does not even reach the half of length of orbit.

18. Back corner of inner branch of *tympanicum* forms a blunt angle.

19. Back branch of *tympanicum* shorter, consequently the line joining the articulation of jaws just meets the back border of *condylus*.

20. If we join by a line the posterior corners of inner branch of *tympanicum* this line just touches the upper border of *foramen magnum*.

21. *Diapophysis* of second vertebra cylindrical, towards middle of outer side we notice a slight protuberance.

22. Outer side of *diapophysis* simply flattened.

23. *Diapophysis* of eighth vertebra of a cylindrical form.

24. *Processi spinosi* of vertebrae shorter.

25. If we draw on pelvis on the upper ridge of ilium crest, a line parallel to base of pelvis, the upper corner of *crista ischio pubica* will remain much below this line.

If we look back on the above tables as well as on the osteological characteristics and description of the Chinese frog we shall find that, owing to all its distinctive features *R. chinensis* can be placed near to *R. ridibunda* Pall, and that neither *R. esculenta* nor *var. lessonæ* seems designated for a closer comparison with it.

Up to now, the glandular folds on the back were alone considered as easily distinguishable characteristic marks; I find, however, that the most important amongst the outer distinctive features are: the general shape of the head, color of vocal sacs, shape of spots on the back and, finally, the formation of inner meta-tarsal tubercle. The head is comparatively very narrow and the snout ends in a very marked point.

My experience is that we never meet with *R. esculenta* having a similarly narrow head or pointed snout. Needless to say that in that respect the Chinese frog differs still more from *Rana ridibunda.* The vocal sacs are of a dusky grey and in that feature it quite resembles *R. ridibunda.*

As regards the spots on the back it differs very markedly from *esculenta,* as already mentioned the spots on the back—on some of the specimens from China—broaden in horizontal direction, giving the back the appearance of being horizontally striped. On other specimens from China the spots are entirely similar in form and disposition, to those of our *esculenta.* The spots on the specimens from Japan present quite a different shape, extending, generally lengthwise on the back, the cross-bars dividing into spots on thigh and tibia, in opposition to the Chinese specimens on which these cross-bars invariably form an uninterrupted dark line. The Chinese frog therefore, as regards the shape of its spots, could be said to somewhat approach the typical *R. ridibunda* in which the spots of the back frequently broaden horizontally.

Finally, I consider the most important mark to be the inner meta-tarsal tubercle—not meaning thereby its proportions as do Boulenger and his adherents—but most especially taking into consideration the differences manifested in its formation and its biological rôle. These differences separate insuperably *Rana chinensis* from the group of either *esculenta* or *ridibunda.* As I already remarked in the above description, the chief difference between the meta-tarsal tubercle of *Rana chinensis* and that of *esculenta* and

var. lessonæ, lies in the fact that it is *never parallel to the length axis of sole, but invariably closes on it at a larger or smaller angle, and that it never stands vertically on the surface of sole but always so to say leans against it.* The most striking difference, however, is—as also Wolterstorff already recorded—the fact of the meta-tarsal tubercle *not adhering to the base of thumb, being independently movable and that of a web extending between it and the thumb.* The above also justifies Osbeck's statement of the Chinese water-frog having six toes as in this case the meta-tarsal tubercle can truly be considered as a sixth toe transformed into a burrowing implement. The edge of the meta-tarsal tubercle is very sharp on the Peking and Tsingtau specimens and quite resembles the meta-tarsal tubercle of *Pelobates fuscus*. This edge is never as sharp on the Pingshiang, Kiukiang and Japan specimens.

The dimensions of the meta-tarsal tubercle frequently vary on specimens from Peking and Tsingtau; it attains the length of the thumb; on specimens collected at other places it is a good deal shorter, but it is never contained twice in the length of the thumb. As regards its rôle in biology, this peculiarity is in itself reason enough for *R. chinensis* to be separated as an independent species.

Once their pools dried up, our *esculenta* and *ridibunda* generally wander further on in search of new waters. Not so with *R. chinensis* which *burrows* itself in the ground as soon as water is wanting. Dr. Kreyenberg (17, p. 136) at Tsingtau, found frogs burrowed under the ground and he writes further on about the Chinese frog digging itself under the earth on the rice fields once the water there has dried up.

It is interesting to notice here that these frogs do not bury themselves thus in exceptional cases, but do this *regularly* with the beginning of the dry season; this being recorded from the surroundings of Peking and Tsingtau most likely happens elsewhere also and seems sufficient explanation of the fact that the meta-tarsal tubercle on the specimens from the above named places is so particularly well developed and so excellent a burrowing implement. It is not improbable that in some parts of those countries this burrowing is only exceptional (the specimens of Kiukiang and Pingshiang do not present so sharp a meta-tarsal tubercle) and it is most likely

that in some parts *R. chinensis* lives an exactly similar life to that of our *R. esculenta* (Kilung, Masempho).

In Wolterstorff's already mentioned article (17, p. 140) we read that the meta-tarsal tubercle of *ridibunda*, *esculenta*, and *var. lessonæ* stands in contrary proportion to the length of the tibia, that is to say, that the larger the meta-tarsal tubercle, the shorter the tibia and reciprocally. He explains this occurrence by the law of correlation; according to his opinion the *R. ridibunda's* leaping faculties are increased through the tibias' length, whilst those of *esculenta* and *var. lessonæ* are augmented by the larger size of the meta-tarsal tubercle. He then continues saying: "If the *R. chinensis* also belonged directly to this series of development, then—considering the size of the meta-tarsal tubercle—the tibia ought to be shorter still, yet just the contrary is stated as it is longer." Wolterstorff further remarks that when hind limbs are bent at right angles to axis of body the heels meet or even rather extend beyond each other. This is stated by Boulenger also (6).

On the specimens examined I found that the *heels never meet.* The reason of this can easily be explained by the Chinese frog's peculiar mode of life. As its burrowing faculties gave it the possibility of remaining in its accustomed place in spite of the water drying up, there was no necessity for wandering, thus its leaping faculties did not particularly develop whilst it possesses the burrowing-faculty's requisites, viz.: thickly set, strong hind limbs. I shall refer later on to the great modification, which wandering may cause in the length of the hind limbs.

After this I am not astonished, that Bedriaga's (17, p. 140) Ordos' specimen was found similar in the length of the hind limbs to *var. lessonæ* of Norfolk.

Referring to the explanation given on the skeleton's distinctive features, I must here again insist upon the fact that they are—according to my opinion—the most important, as the skeletons which I prepared all present the above mentioned characteristic marks, although they belonged to frogs originating from different places. The particularities most worthy of attention are on the skull: the position of nasals, the shape and dimensions of the zygomatic process as well as the fact of the condylus always extending beyond the line joining the articulation of the jaws, finally the shape

and position of the vomerine teeth group. The bony ridge visible on the diapophysis of the third vertebra of the vertebral column, as well as the characteristics in connection with the pelvis, are also exceedingly important marks.

I cannot, after these results, accept Wolterstorff's opinion (17, p. 139) that the Chinese frog is a now-arising, not yet fully expressed species, whose characteristics in the formation of the legs have not yet quite developed in each specimen. With regard to the metatarsal tubercle, my conviction is that it has reached its full development, but that, owing to climatic conditions and natural surroundings it varies in formation according to countries.

If we look back upon what has been said above, it becomes immediately clear to us that the Chinese frog bears the mixed characteristics of *R. ridibunda* and *R. esculenta*, and it is just this mixture of distinctive features which proves that we have to do with independent species. This is also confirmed by its geographic distribution. The Chinese frog is to be found—as is reported—from Vladivostok in the North down to Bangkok in the South, and from Japan westwards to the 105–110° eastern longitude. In opposition to this *Rana esculenta*, respectively the *var. lessonæ*, is to be found until the 30° eastern longitude, whilst *ridibunda* is met with as far as Persia. The fact of its geographic distribution being confined within such definite limits, seems to be a proof more, that *R. chinensis* belongs to an independent species as it were difficult to suppose that alone one variety of *esculenta* lived on such an immense territory, within so great a distance of the circle limiting the typical form's natural boundaries. If *R. chinensis* meets with any western species it can only be with *Rana ridibunda*. Boulenger supplies us in his work "The Tailless Batrachians of Europe," with a map (p. 263) marking the *esculenta* group's geographic distribution. Wolterstorff remarks (17, p. 142) that on this map he finds the limits of *Rana chinensis*' geographic distribution rather far extended westwards. My opinion is that the distance between these two species is not even as great as that, but that they most likely directly meet somewhere. This question could only be solved by a minute investigation in the regions of Asia Minor and Tien-san.

My studies on the Chinese frog have led me to the conclusion that it is not the Chinese frog which originates from *R. esculenta* or *R.*

ridibunda, but on the contrary both *R. esculenta* and *R. ridibunda* from *Rana chinensis*.

I wish to support this supposition by the inner meta-tarsal tubercle. As is already known the inner meta-tarsal tubercle of frogs has developed from the ancestral thumb, the former sixth toe. If during the development of the body any part of it is arrested in its growth and decays, it regenerates no more. This is the fact on which I found my explanation. In the above description I have already pointed out the fact that the meta-tarsal tubercle of the Chinese frog is truly no meta-tarsal tubercle at all, but a real finger connected by a web to the present thumb. The Chinese frog, influenced by surroundings and climatic conditions, adapted itself to the already mentioned peculiar mode of life and its ancestral thumb just only transformed itself so far as to become its burrowing implement.

In opposition to this it is quite evident that the meta-tarsal tubercle of *Rana ridibunda* and *Rana esculenta* has quite degenerated inasmuch as through adaptation to new conditions, it increases its dexterity in leaping. On account of this, therefore, it would be impossible to suppose that the Chinese frog's meta-tarsal tubercle together with the web between it and the first toe is a new acquisition.

I found on *Bufo viridis* Laur. a most convincing proof of the change in the hind limbs caused by wandering. In one of my articles (p. 166) whilst comparing the *Bufo viridis* of county Gömör (Hungary) to *Bufo viridis* of Konia (Asia Minor) I pointed out the fact of the specimens from Asia Minor having comparatively a good deal longer hind limbs than those from the county Gömör. After the publication of that article my friend Mr. D. v. Földváry who undertook a journey in Asia Minor in the year 1906, informed me having repeatedly met in the deserts with *Bufo viridis*, wandering in search of new pools after their former resorts had dried up.

It seems likely therefore, that the hind limbs of the specimens from Asia Minor were thus developed in consequence of this frequent wandering, and it is to be presumed that Hungarian specimens have shorter hind limbs, because they never wander. Taking these above facts into consideration it will seem more probable still that *Rana ridibunda* and *Rana esculenta* were derived from the Chinese frog whilst this latter was extending westwards; the in-

fluence of surroundings and climatic conditions then co-operated in the formation of the longer hind limb and with it the greater facility to leap. This opinion of mine differs very essentially from Wolterstorff's (17, p. 139) who wishes to prove by the Chinese frog's example the way in which a former leaping-frog gradually transformed itself into a burrowing-frog. He mentions as an example the *Pelobates* genus, which he believes to have originated in that same manner.

This seems refuted according to my opinion by the very fact of such frogs, as bearing the ancestral characteristic features—(as the *Pelobates* for instance)—being none of them agile leapers in opposition to the undoubtedly younger race of *Ranae fuscae*, of which every representative is most dexterous in leaping.

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Explanation of Plate VI.

Fig. 1. First toe of hind limb, with shovel-like inner meta-tarsal tubercle. Peking. × 1.5.
Fig. 2. Skull, upper view. Kiukiang. × 1.5.
Fig. 3. Skull, under view. Kiukiang. × 1.5.
Fig. 4. Skull, back view. Kiukiang. × 1.5.
Fig. 5. Second vertebra of Rana esculenta L. upper view. Bariás, (Hungary). × 2.
Fig. 6. Second vertebra, upper view. Kiukiang. × 1.5.
Fig. 7. Third vertebra, upper view. Kiukiang. × 1.5.
Fig. 8. Eighth vertebra, upper view. Kiukiang. × 1.5.
Fig. 9. Pelvis from side. Kiukiang. Nat. Size.
Fig. 10. Pelvis of Rana esculenta L. from side. Bariás (Hungary). Nat. size.
Fig. 11. Bones of tarsus. Kiukiang. × 3.
Fig. 12. Tarsal bones of Rana esculenta L. Rimanambat. (Hungary.) × 3.